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PREPRINT

EFFECTS OF PERIGEE ROTATION ON ORBITAL FLUX INTEGRATIONS

(Partial, Preliminary Results)

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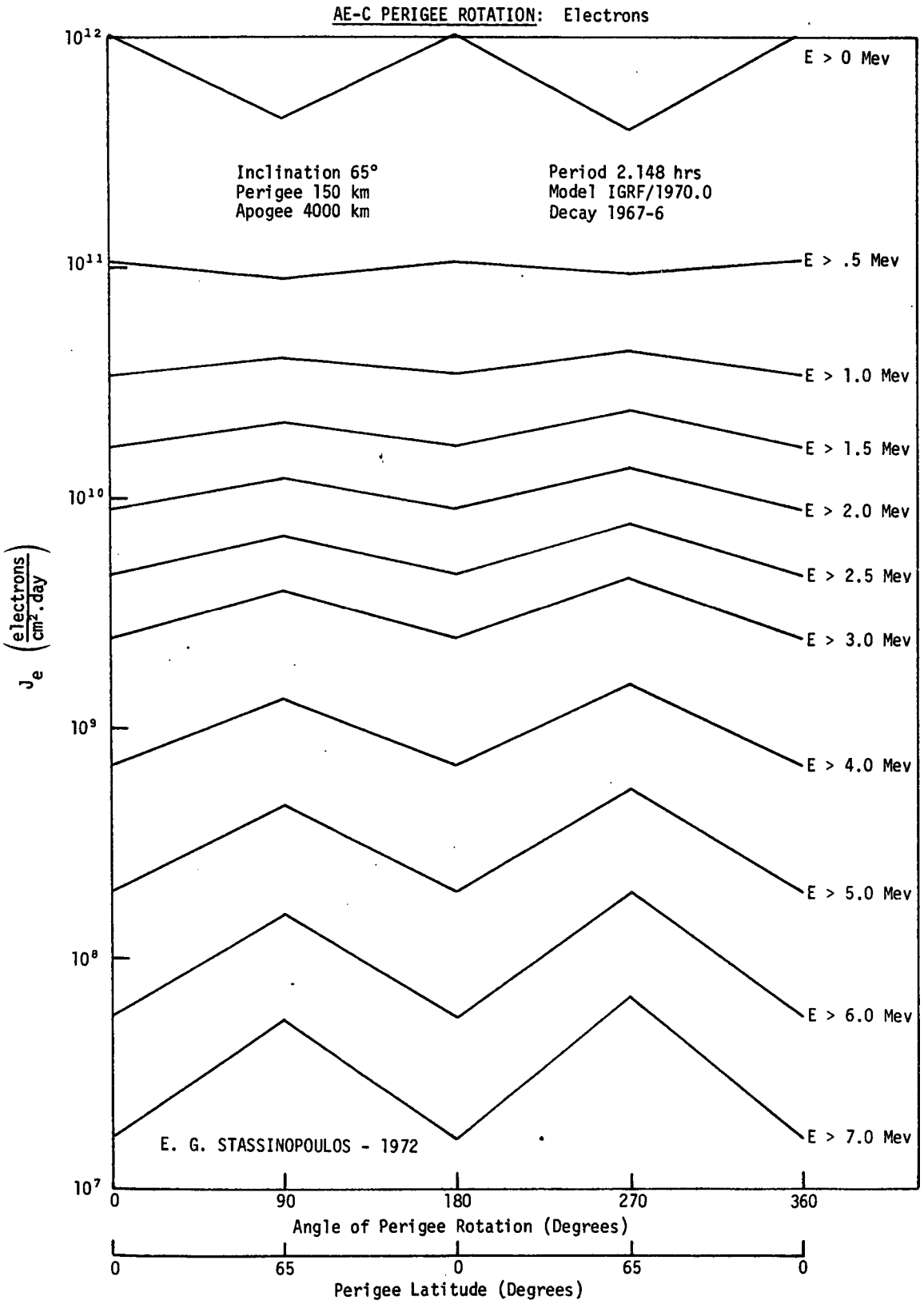
This study was conducted at the request of the AE Project Office to determine how orbit integrated fluxes of non-circular trajectories with eccentricities in the range of about .2 to .5 are affected by changes in the location of the initial injection position. Specifically, by customarily placing the initial injection point of a nominal trajectory (the location of the first perigee position) arbitrarily at the node of the orbit plane with the equatorial plane, the resulting flux calculations may have been biased. It is concievable that a rotation of the first perigee in the plane of the orbit and a relocation, let us say diametrically opposite or rotated by 90 degrees, may produce substantially different results. Since the results are statistically treated averages, it would make no difference if a stationary earth is considered for the initial position definition or if a specific meridian is placed at the node. Thus, in the geocentric coordinate system, longitude is not a critical parameter, neither is altitude, which remains constant. Consequently, and predictably when perigee is rotated, only the change in latitude may account for the variation in the orbit integrated fluxes.

Although our study is still incomplete (test calculations have only been partially concluded) enough data is available at this time to describe the expected variation. In the following paragraphs, a quantitative evaluation of a nominal AE trajectory (65° inclination, 150 km perigee, 4000 km apogee, and eccentricity .228) is presented in terms of perigee rotation. The attached plots show the effects of the rotation on the levels of average, vehicle-encountered, orbit-integrated proton and electron fluxes for this specific trajectory. It is expected that changes in eccentricity, inclination, and/or perigee altitude will alter the results. The particle intensities given are daily averages at the integral energies indicated. Uncertainty factors are about 2 for the protons and about 3-4 for the electrons. The electron fluxes were appropriately decayed to background levels, so as to remove the artificial component from the environment model.

It is evident from the attached plots, that significant variations in the flux levels, as well as in the spectra, occur with perigee rotation, involving both, electrons and protons. The protons display their greatest variation (> order of magnitude) at relatively low energies ($E > 3$ and > 5 Mev) while they show almost no change at energies $E > 50$ Mev. This information may be very useful in a decision-making process, where radiation hazard or dosage is a mission criterion. If, for example, a specific component or experiment is severely affected by trapped protons in the energy range $3 > E(\text{Mev}) > 50$, then a proper rotation in perigee may reduce the incident proton intensities by about a factor of 10-15.

A similar but opposite effect is observed with the electrons. They display almost no change with perigee rotation at low energies (E > .5 and > 1 Mev), while at higher energies they show increasingly greater variations, (E > 5 and > 7 Mev), which at E > 7 Mev is about a factor of 4. It is reasonable to assume that this trend would continue towards still higher energies. An inversion is apparent between E > .5 and E > 1. Mev. No explanation can be offered at present. The extrapolated E > 0 Mev contour should be ignored.

Tests continue for various inclinations, eccentricities, and perigee altitudes. As soon as these are concluded and the data has been studied and analyzed, a comprehensive report on the subject matter will be published.


AE-C PERIGEE ROTATION: Electrons
10^{12}
10^{11}
10^{10}
10^{9}
10^{8}
10^{7}
E > 0 Mev
Inclination 65°
Perigee 150 km
Apogee 4000 km
Period 2.148 hrs
Model IGRF/1970.0
Decay 1967-6
E > .5 Mev
E > 1.0 Mev
E > 1.5 Mev
E > 2.0 Mev
E > 2.5 Mev
E > 3.0 Mev
E > 4.0 Mev
E > 5.0 Mev
E > 6.0 Mev
E > 7.0 Mev
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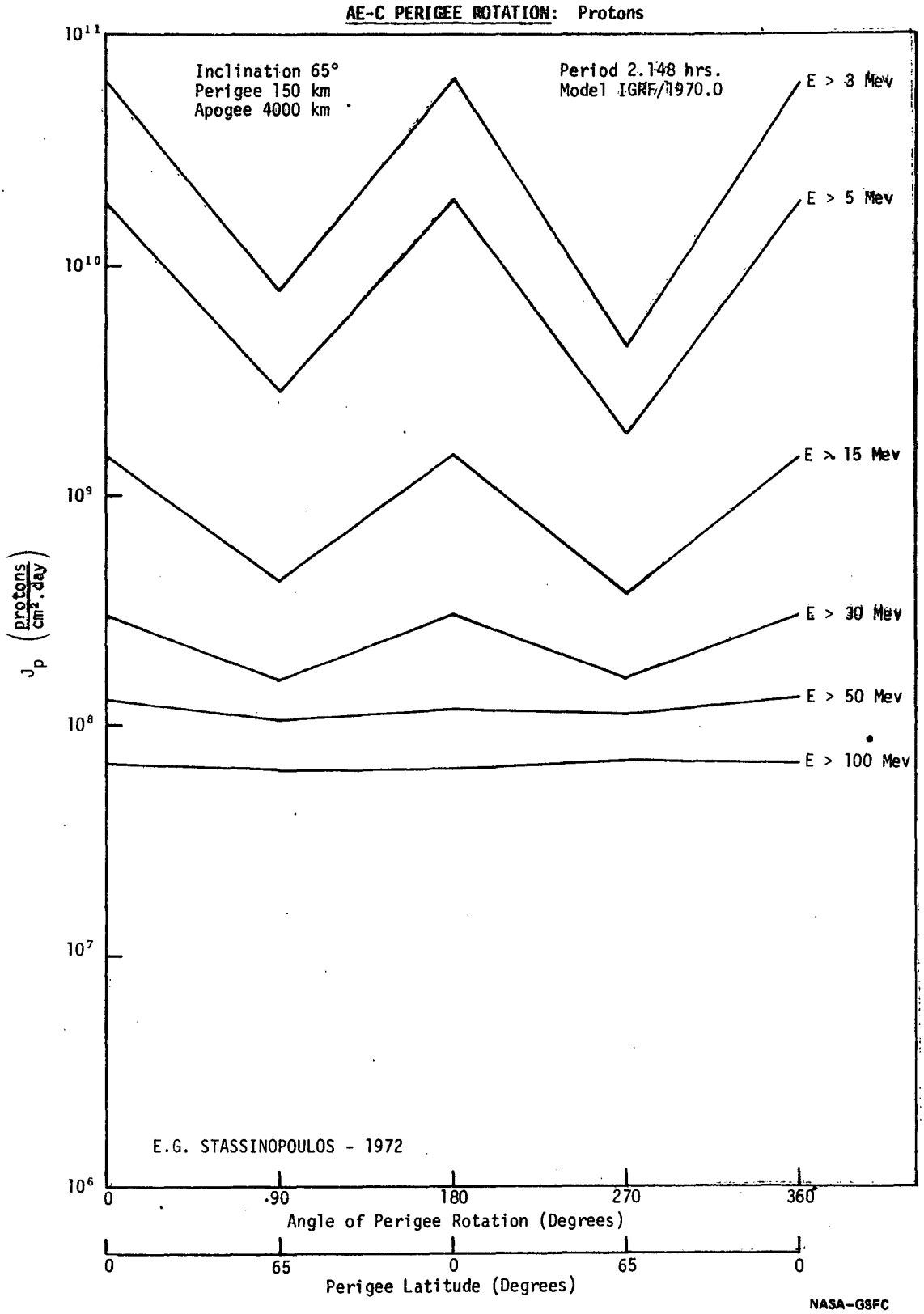
$J_e \left(\frac{\text{electrons}}{\text{cm}^2.\text{day}}\right)$
0
90
180
270
360
Angle of Perigee Rotation (Degrees)
0
65
0
65
0
Perigee Latitude (Degrees)


AE-C PERIGEE ROTATION: Protons
Inclination 65°
Perigee 150 km
Apogee 4000 km
Period 2.148 hrs.
Model IGRF/1970.0
E > 3 Mev
E > 5 Mev
E > 15 Mev
E > 30 Mev
E > 50 Mev
E > 100 Mev
10^{11}
10^{10}
10^{9}
10^{8}
10^{7}
10^{6}
J_p (protons/cm².day)
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0
90
180
270
360
Angle of Perigee Rotation (Degrees)
0
65
0
65
0
Perigee Latitude (Degrees)
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